

A SCANNING ELECTRON MICROSCOPE STUDY OF  
THE BUCCAL COMPLEX OF *METAPENICULUS*  
*ANTOFAGASTENSIS* (COPEPODA: PENNELLIDAE)

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*Abstract.*—The buccal complex for the copepodite, chalimus and adult stages of *Metapeniculus antofagastensis* Castro & Baeza, 1985 is examined and described with the aid of the scanning electron microscope (SEM). The junction between the labium and labrum of the buccal cone at the copepodite stage is shown to be affected by the insertion of the edges of the former between the dorsal and the ventral plates derived from the latter and linked together by a vertical bridge. The formation of the proboscis, following the process of metamorphosis, results in the displacement of the buccal area from the ventral surface of the cephalothorax and from the second maxillae, which remain in their original position on that surface. The intrabuccal armature is described, as is the mandible at different developmental stages. Differences in the morphology of the buccal region of *Peniculus* and *Metapeniculus* are described. Reference is made also to the genus *Ophiolernaea*.

The buccal area of the copepods parasitic on fishes is still inadequately known. Kabata (1974) described the structure of the buccal tube with its associated musculature, as well as the oral appendages and the mode of feeding of *Caligus* (Caligidae), an ectoparasite genus. A similar description was published for the genus *Lepeophtheirus* by Boxshall (1984). Several authors studied the oral region of mesoparasitic (Kabata 1979) copepods belonging to the family Pennellidae. Gooding & Humes (1963) described the buccal area of *Haemobaphes cyclopteri-na* and John & Nair (1973) that of *Lernaenicus hemirhamphi* and discussed their functional morphology. Kabata (1979) gave a general account of this area in Poecilostomatoida and commented also on the structure of the buccal tube of Pennellidae. Recently, Chandran & Nair (1988) gave an account of the functional morphology of this area in *Pseudocharopinus narcinae*.

In spite of these publications, the buccal tube and the intrabuccal armature is still inadequately known, because this structure

is very small and difficult to study in detail, specially in the pennellid copepods.

In their search for some structural details that could throw new light on the taxonomy of the Pennellidae, the authors studied the buccal complex of *Metapeniculus* Castro & Baeza, 1985 and compared it with that of *Peniculus* von Nordmann, 1832. This paper illustrates and discusses the results of this study.

*Methods.*—Specimens of *M. antofagastensis*, copepodites, chalimus and adult, were collected from their host fish (*Anisotremus scapularis*), both juvenile and adult. Some fish were taken from their natural environment, while others were reared in a laboratory. The copepods were washed in sea water that was filtered through a millipore filter. They were rinsed in 1M urea to remove fish mucus from the attached specimens, fixed in gluteraldehyde (4%). They were dehydrated in ethanol, critical point dried and then coated with gold or silver, observed and photographed under an Autoscanner or Jeol Scanning Electron Micro-

scope at 20 Kv. Light microscopy drawings were made with the aid of a camera lucida.

### Results

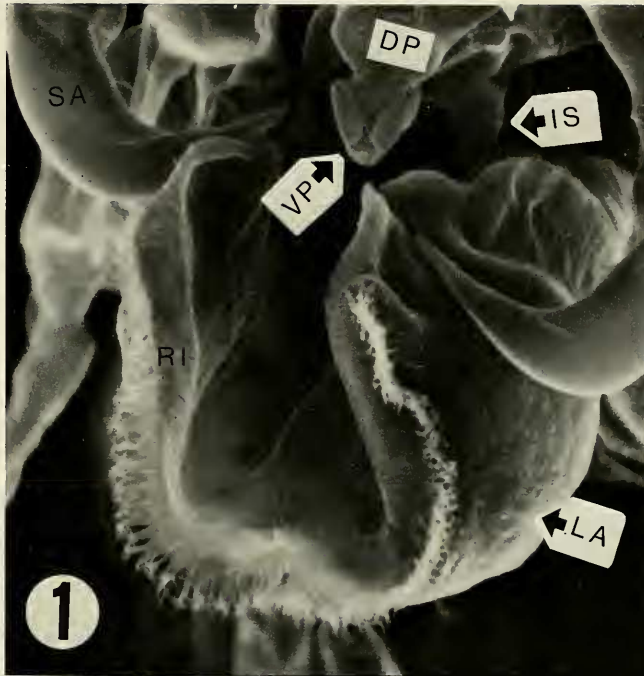
*Copepodite* (Figs. 1, 2).—The buccal tube (Fig. 1) is formed by both the labium and labrum. The former forms most of the circumference of the tube and bears a fringe of setules at its distal end. The latter is a subtriangular plate, connecting with subcylindrical plate by means of a vertical bridge. Two intrabuccal stylets are present on the inner surface of the labrum near its distal end. The stylets are short, robust and surmounted by a single setiform process. The first maxilla (Fig. 2) is located at the base of the labium. It has the usual pennellid structure. Its exopod is a single seta with a robust base, whereas its endopod carries two long setae. Posteromedial and close to the first maxilla is the mandible, which is an unsegmented stylet with a bifid apex (Fig. 2). The second maxilla is bi-segmented, and is situated posterior to the labrum. Its first segment (=lacertus) and second segment (=brachium) are unarmed. The distal claw carries several spines apically.

*Chalimus I and III* (Figs. 3–7).—At the first chalimus stages (Fig. 3) the anterior inner surface of the labium is produced into two prominent plate-like swellings (Fig. 3). At the third chalimus stage (Figs. 4, 5) the structure of the buccal cone and tube approaches its definitive condition; the labrum and labium are linked at their distal ends. The upper margin of the labium are inserted between the subtriangular dorsal plate (dp) and subcircular ventral plate (vp) (Fig. 6). At this stage the projections of the inner surface of the labium and the intrabuccal armature of the tube reach their definitive shape (Fig. 7) (Chalimus III is the juvenile stage for this genus). The mandible enters the buccal tube through an opening at the junction of the labium and labrum. Other appendages retain their original position.

*Adult* (Figs. 8–11).—The peribuccal area is changed due to the development of a proboscis that pushes the small buccal cone and tube away from the surface of the cephalothorax (Fig. 8). The labrum is now greatly reduced and simple, whereas the labium, which forms most of the buccal tube, consist of three heavily sclerotized rings and is armed with a distal ring of setules. The distolateral surface of the buccal cone bears several microvellosities (Fig. 9, mi). The mandible is difficult to study due to its small size. As far as can be seen, in the adult copepod it is a simple stylet, devoid of dentition. The second maxilla remains at its original position close to the base of the proboscis. The intrabuccal structure has the appearance of two long, wide laminae (Figs. 3, 10, 11) arising from the base of the labium (that is starting from the buccal cone area) with some folding near their tips (Fig. 10, ia), and reaching the buccal opening when the buccal tube is contracted.

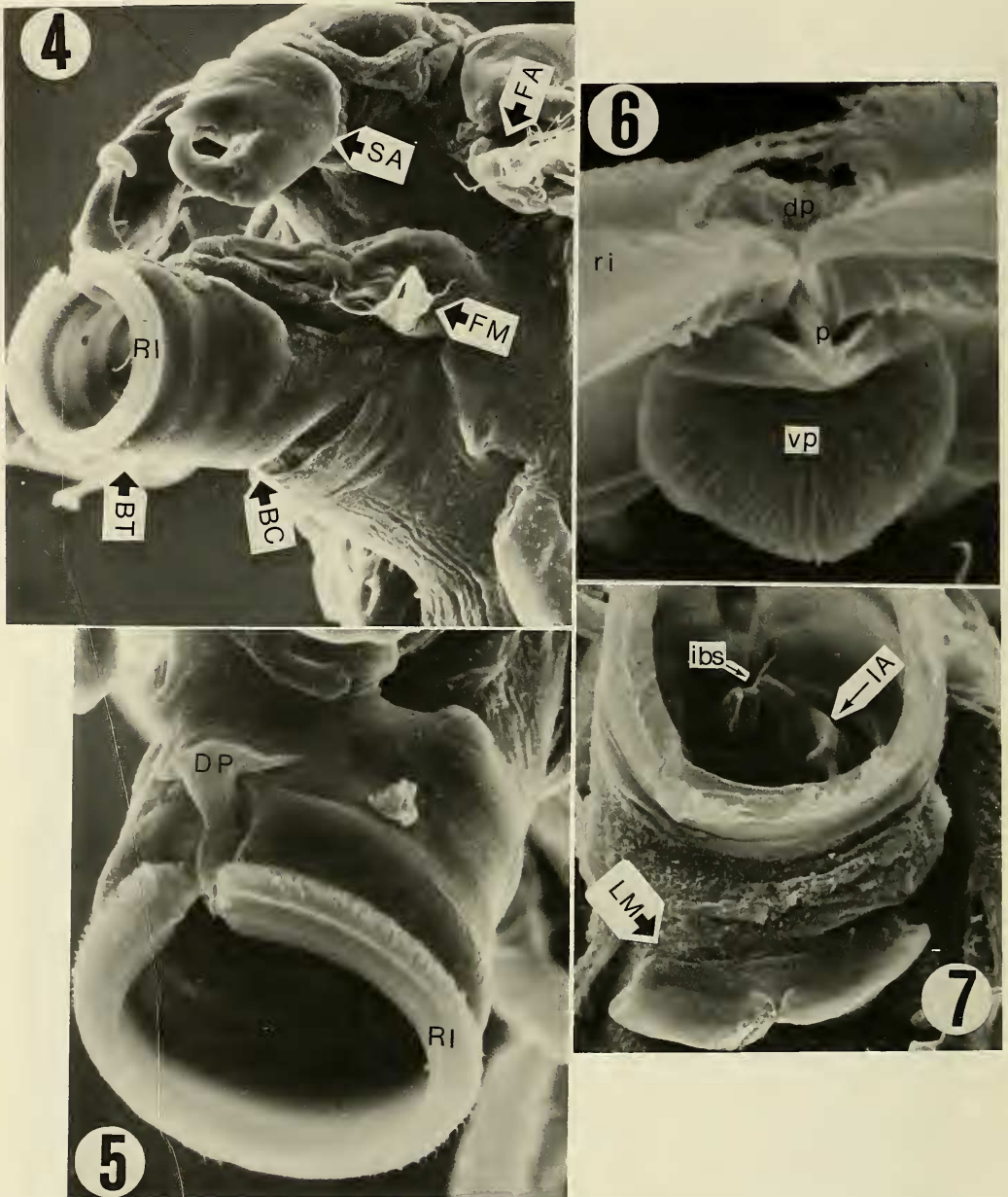
### Discussion

The buccal apparatus of Pennellidae consists of the cone and tube, the former formed by the fusion of the labrum and labium (Kabata 1979). It has now been recognized that the labrum produces a ventral plate (cuticular process of Gooding & Humes 1963; dorsal plaque of Kabata 1979). Gooding & Humes (1963), suggested that the plaque fused with the labium. This would prevent the tube from telescoping to any appreciable extent, although Kabata postulated that the pennellid tube can telescope. The structure of the buccal tube of *Metapeniculus* supports Kabata's assertion. The telescoping (of the buccal tube) is made possible due to the loose insertion of the distal upper margin of the labium, between the dorsal and ventral plates derived from the labrum, allowing free movement of the labium. The buccal tube, supported by three incomplete sclerotized rings, is common for all genera of Pennellidae. While in the majority of these

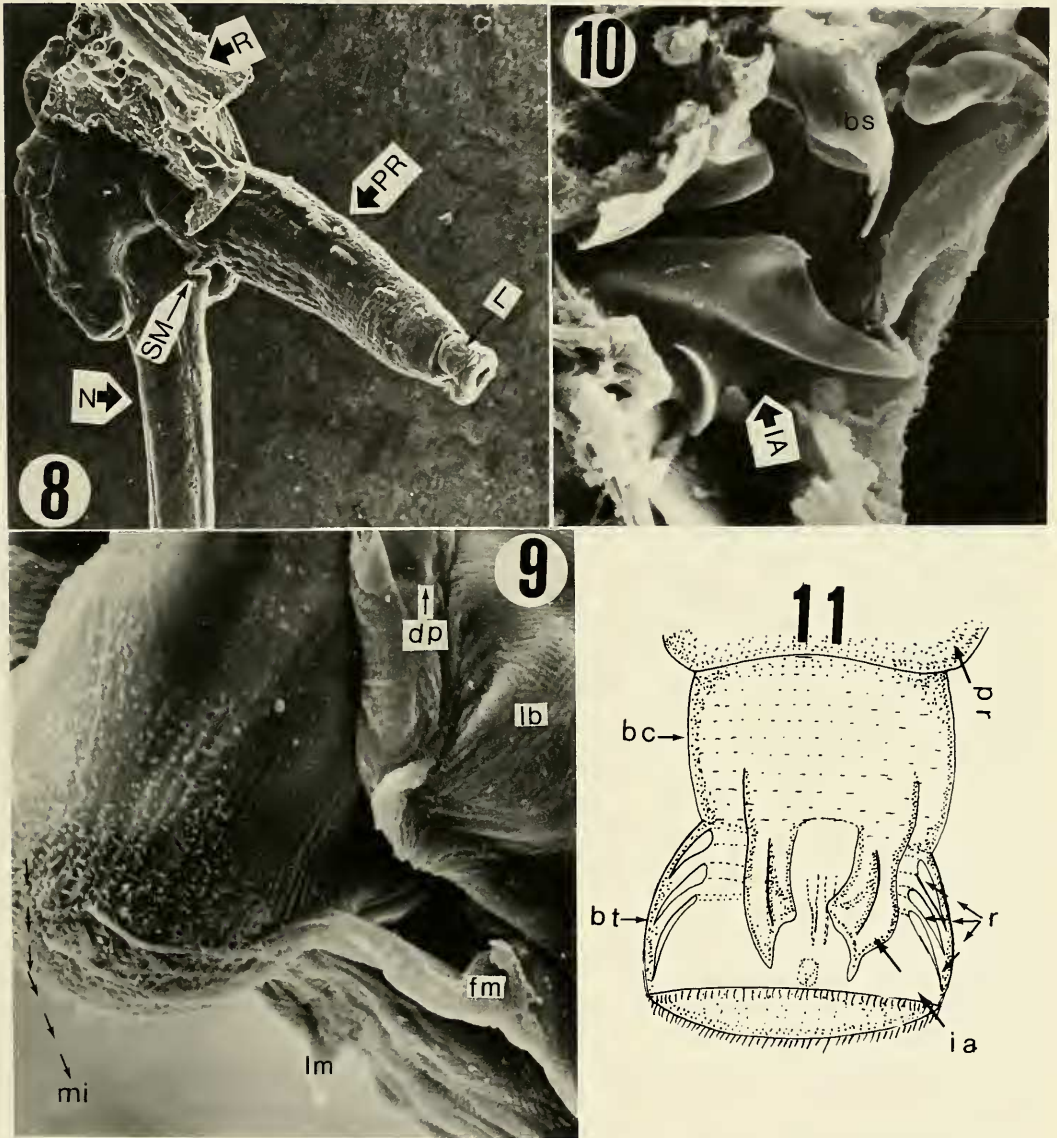


Figs. 1-3. Copepodite and chalimus I of *Metapeniculus antofagastensis*. 1. Copepodite, frontal view of the buccal area, showing the labium, and the dorsal and ventral plates. 720 $\times$  (LA = labium, DP = dorsal plate, IS = intrabuccal stylet, SA = second antenna, VP = ventral plate, RI = rim).

2. Copepodite, detail of the first maxilla and mandible. 1730 $\times$  (fm = first maxilla, M = mandible). 3. Chalimus I, detail of the labium, showing the plate-like swellings. 600 $\times$  (A = plate-like swellings, LA = labium).



Figs. 4-7. *Chalimus* III and premetamorphosis female of *Metapeniculus antofagastensis*. 4. *Chalimus* III, buccal area, lateral view. 400 $\times$  (BT = buccal tube, BC = buccal cone, FA = first antenna, FM = first maxilla, SA = second antenna). 5. *Chalimus* III, buccal tube, dorsal view, showing the dorsal plate position. 800 $\times$  (RI = rim, DP = dorsal plate). 6. *Chalimus* III, detail upper margin of the rim showing the insertion of the labium between the dorsal and ventral plates. 400 $\times$  (ri = margin, vp = ventral plate, dp = dorsal plate, p = bridge). 7. Premetamorphosing female, showing the intrabuccal armature. 400 $\times$  (ibs = intrabuccal stylet, IA = intrabuccal armature, LM = lamina, RI = rim).



Figs. 8–11. Adult female of *Metapeniculus antofagastensis*. 8. Adult female, cephalic area, showing the proboscis and buccal area. 52× (PR = proboscis, L = labrum, Sm = second maxilla, N = neck, R = fin ray fragment of host fish). 9. Buccal tube detail showing the microvellosities (MI = microvellosities, dp = dorsal plate, lm = lamina). 10. Detail of plate-like swelling (= intrabuccal armature) in a buccal tube longitudinal section. 800× (IA = intrabuccal armature, ibs = intrabuccal stylet). 11. Detail of the buccal area, showing the intrabuccal armature as seen by transparence (ia = intrabuccal armature, bt = buccal tube, bc = buccal cone, pr = proboscis, ri = rings of the buccal tube).

genera the buccal area is situated close to the ventral surface of the cephalothorax (i.e., a short buccal area in *Peniculus* and *Lernaenicus*) in *Metapeniculus* it is displaced away from it as the consequence of the de-

velopment of a prominent proboscis, resulting from the activity of the oral development centre (Kabata 1979). The length of the proboscis is exceeded only by that of *Ophiolernaea* Shiino, 1958. Boxshall (1986)

pointed out that *Peniculus elongatus* shows an incipient proboscis, indicative of a tendency towards the elongation of a proboscis in this family.

The existence of a prominent proboscis in *Metapeniculus* supports Boxshall's view. Although the genera *Peniculus* and *Metapeniculus* share similar attachment sites on their respective hosts the relative lengths of their proboscis differ considerably. The position of the second maxilla also varies between pennellid genera. In *Metapeniculus* it remains at its original position at the base of proboscis, but in *Ophiolernaea* it migrates with the buccal area to the tip of its extraordinarily long proboscis close to the first maxilla (cf. Ho 1966: figs. 25–27).

The buccal apparatus was hitherto believed to consist of the mandible, first and second maxillae and intrabuccal stylets. This study disclosed the presence of another component of this apparatus, the two long plate-like swellings derived from the proximal part of the inner surface of the labium. They are very difficult to observe with the aid of a low magnification and can only be detected in specimens made translucent by treatment with lactic acid and observed under higher magnification. The laminae are already present in the copepodite stage and complete their development at the final chalimus stage. By eroding the host tissue the laminae are probably able to supplement the function of the mandible, especially when the latter is short and weak as in *Metapeniculus*. The shape of the armature appears to be different in *Metapeniculus* and *Peniculus*. (Their shape for the latter of these genera is now being examined by the authors.)

The pennellid mandible is usually bipartite and armed with teeth, e.g., in *Lernaeocera* (see Kabata 1962) and in *Haemobaphes* (see Gooding & Humes 1963). The mandible of *Metapeniculus*, in contrast, is unsegmented, bifid at the copepodite stage and apparently undivided at the apex and devoid of teeth in the adult.

The structure of the adult mandible, however, requires further study. In this respect also, there exist clear differences between *Peniculus* and *Metapeniculus* in these morphological details. Further study of the buccal region might disclose differences of a similar kind in different genera of the family. The knowledge of these differences might lead to a better understanding of the functional morphology of this area and of the evolutionary trends exhibited by the pennellid copepods.

#### Acknowledgments

Special thanks are extended to the staff of Electron Microscopy of the Universidad de Concepción, and Universidad Católica del Norte (Sede Coquimbo), for their technical assistance and to all those people who helped us collect samples, and to anonymous reviewers who improved the final manuscript. This study represents a portion of a project sponsored by FONDECYT 0069/88.

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